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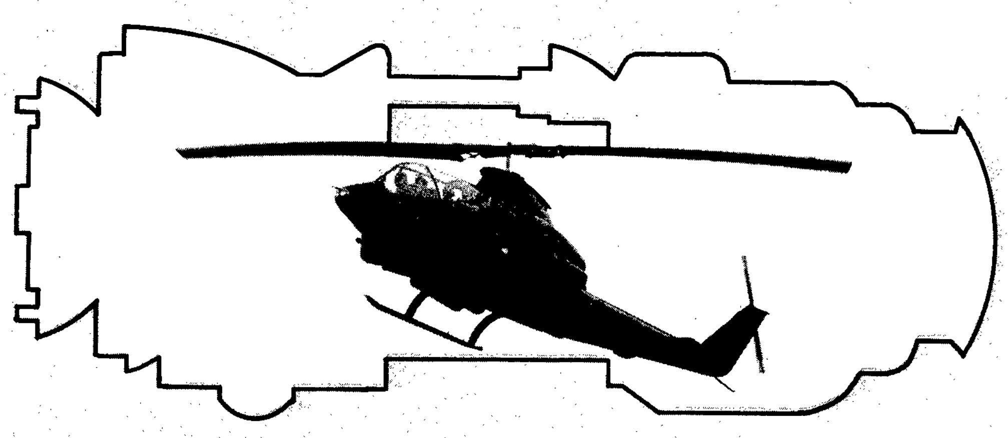
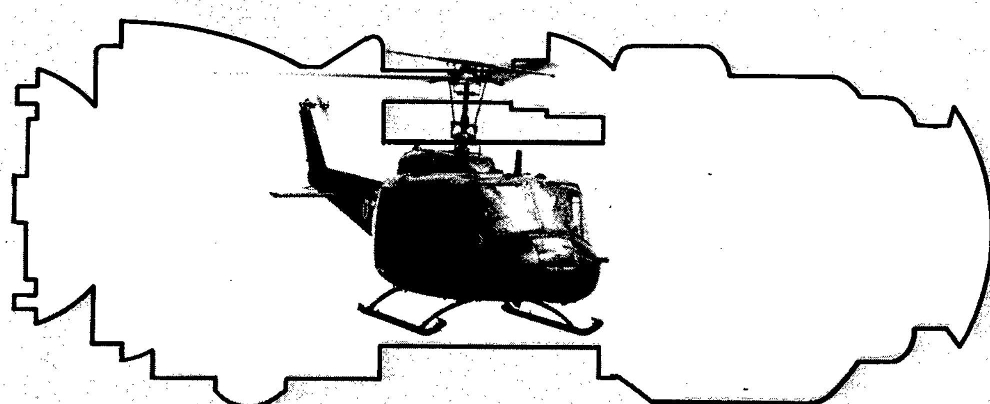
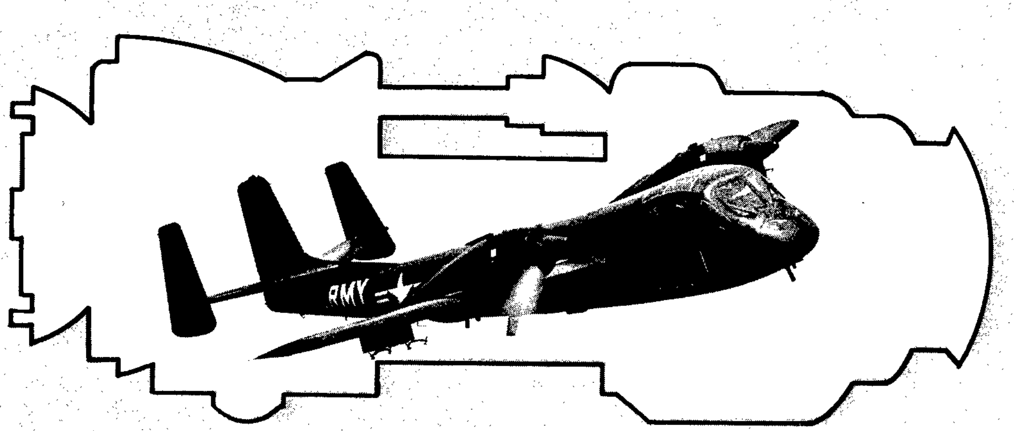
T53







ENGINE REPORT

PAm 74-11

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T53 ENGINE EXPERIENCE REPORT

1 JANUARY 1970 THROUGH 31 MARCH 1974

INTRODUCTION

This report contains all available mishap data involving failure or malfunction of the Lycoming T53 series gas turbine engine from 1 January 1970 through 31 March 1974. The data is categorized into three groups—T53-L-11 series engine that powers the UH-1B, UH-1C, and UH-1D; T53-L-13 series engine that powers the AH-1G, TH-1G, UH-1H, and UH-1M; and the turboshaft T53-L-7, 15, and 701 that powers the OV-1B, OV-1C, and OV-1D. The turboshaft mishaps are placed in one group because the only aircraft concerned is the OV-1.

The mishap experience portion of the report addresses only aircraft and engines in service at the present time. But in order to give a more complete understanding of the evolution of the T53 series, Appendix A covers the T53 series from -5 to -701, with applicable aircraft installation, fuel regulator, and governor data.

This report was prepared to aid commanders, aviation safety officers, maintenance personnel, aviators, and related aviation personnel in accident prevention and the preservation of combat resources through a review of past engine-related mishaps. The term "mishap" includes accidents, incidents, forced landings, and precautionary landings as defined in paragraph 2-9, AR 385-40, dated August 1972.

SUMMARY

T53 series engine failures and/or malfunctions were a factor in 2,614 mishaps for the period covered (table 2). One thousand eight hundred and ninety-four mishaps involved the T53-L-13 series; 553, the T53-L-11 series; and 167, the T53-L-7, 15, and 701 turboprop. The T53-L-13 series powered aircraft had 247 major accidents, 103 of which were total losses. The T53-L-11 series powered aircraft had 60 major accidents, 31 of which were total losses. The T53-L-7, 15, and 701 turboprop series had six major accidents, all of which were total losses.

One thousand four hundred and thirty mishaps occurred in Vietnam, 854 in CONUS, and 114 in Germany.

The mishap frequency rate for the T-53-L-11 series (UH-1B, C, and D) for 553 mishaps in 1,742,961 flying hours was 31.72 per 100,000 flying hours. The T53-L-13 series (UH-1H, UH-1M, AH-1G, and TH-1G) had 1,894 mishaps in 5,449,314 hours for a rate of 34.75 mishaps per 100,000 hours. The T53-L-7, 15, and 701 series had the highest rate at 78.47 mishaps per 100,000 flying hours with 167 mishaps in 212,805 hours. For the period covered by this report, there were 2,614 mishaps in 7,405,080 flying hours, for an overall rate of 35.30 mishaps per 100,000 hours.

Of the 5,930 personnel on board in all mishaps, 5,377 received no injuries. However, 181 fatalities, 127 major injuries, and 245 minor injuries occurred.

The dollar cost resulting from engine-related mishaps for this period was $43,718,937.

CONCLUSIONS

The single greatest problem with the T53 series engine was fuel control related, with 293 mishaps reported. The second most prevalent problem was the lubrication system, with 279 mishaps reported. A detailed breakout of these problems by engine type can be found in table 9.

Table 6 was constructed in an attempt to relate mishaps with hours since new or overhaul, but with each engine series, the "unknowns" number more than half the properly reported mishaps. This table is an excellent example that

all data requirements must be met when a powerplant-related crash facts message is submitted. A review of the mishap cause factors involving the T53 engines indicates that improved management, indepth quality control, participation in the EIR program, and a well conducted accident prevention program can greatly enhance the present Army aviation program.

DISCUSSION

Two major problem areas that have appeared in practically every accident prevention study conducted by USAAAVS appeared again in this report. The first problem is that unit safety officers do not provide the required information when the powerplant is the cause or suspected cause of a mishap. AR 95-5, change 3, chapter 14, paragraph 14-1, states: "Crash Facts Message Report (14): Describe any known or suspected materiel deficiencies. Give the control number of DA Form 2407 pertaining to Section III, Equipment Improvement Recommendation (EIR). Give complete FSN, part number, and nomenclature of the suspected or failed part, and the name of the publication from which this information was obtained. If *engine failure* or *malfunction* is a factor, submit *engine model, series, serial number, total time, time since overhaul* (report to nearest hour), *overhaul facility, date of last overhaul, previous storage history, cause of failure, power settings,* and *significant engine indications.*" If this data is not submitted as stated above, there is no way to accurately track the engine before or after the mishap to insure that a trend is not developing. A close study of table 6 will give the reader an accurate portrait of how difficult it is to detect a trend from crash facts data if the specific items of information are not complete. During the period covered by this report, engine

TABLE 1.–T53 Series Engines

	OV-1B, C, D TURBOPROP			AH-1G, UH-1B, D, H, M TURBOSHAFT			
T53-L-	**7/7A**	**15 (1)**	**701 (1)**	**9A**	**11/11A**	**11C/11D (2)**	**13A/B (1)**
Overall Length	58.4"	58.3"	59.3"	47.8"	47.6"	47.6"	47.6"
Max. Diameter	23.0"	24.3"	23.0"	24.8"	23.0"	23.0"	23.0"
Max. Radius	13.3"	12.1"	14.9"	13.3"	13.5"	13.5"	13.5"
Dry Weight	555 lbs	605 lbs	688 lbs	490 lbs	496 lbs	499 lbs	540 lbs
Trapped Oil	5 lbs	5 lbs	6 lbs	3 lbs	3 lbs	3 lbs	3 lbs
Trapped Fuel	4 lbs	4 lbs	4 lbs	2 lbs	2 lbs	2 lbs	2 lbs
ROTATIONAL DIRECTIONS							
Compressor Rotor	CCW	CCW	CCW	CCW	CCW	CCW	CCW
1st Stage Turbine	CCW	CCW (4)	CCW (4)	CCW	CCW	CCW	CCW (4)
2nd Stage Turbine	CW	CCW (4)	CCW (4)	CW	CW	CW	CCW (4)
3rd Stage Turbine	N/A (3)	CW (4)	CW (4)	N/A (3)	N/A (3)	N/A (3)	CW (4)
4th Stage Turbine	N/A (3)	CW (4)	CW (4)	N/A (3)	N/A (3)	N/A (3)	CW (4)
Power Shaft	CW	CW	CW	CW	CW	CW	CW
MISCELLANEOUS							
Reduction Gear Ratio	12.40:1	12.40:1	12.38:1				
Compressor Ratio	6:1	7:1	7:1	6:1	6:1	6:1	7:1
Altitude (Absolute)	25,000 ft	25,000 ft	25,000 ft	25,000 ft	25,000 ft	25,000 ft	25,000 ft
Operating Temperature	−54° +38°C	−54° +57°C	−54° +57°C	−54° +54°C	−54° +54°C	−54° +54°C	−54° +57°C
Range	−65° +100°F	−65° +135°F	−65° +135°F	−65° +130°F	−65° +130°F	−65° +130°F	−65° +135°F

(1) These engines have variable inlet guide vanes.
(2) Also T53-L-11 S/N suffix "A," 11B, C, D.
(3) These engines have one gas producer turbine and one power turbine.
(4) These engines have two gas producer turbines and two power turbines.

TABLE 2.–Mishap Classification

Year	Total Loss	Major	Minor	Incident	Forced Landing	Precautionary Landing	Total
				UH-1H, UH-1M, AH-1G, TH-1G (T53-L-13)			
1970	71	91	5	100	193	258	718
1971	19	36	1	50	111	334	551
1972	8	13	1	21	48	203	294
1973	4	3		17	36	201	261
1974*	1	1		3	9	56	70
Total	103	144	7	191	397	1,052	1,894
				UH-1B, UH-1C, UH-1D (T53-L-11)			
1970	18	17		26	59	139	259
1971	9	10		16	40	120	195
1972	1		1	4	10	36	52
1973	3	1		3	5	26	38
1974*		1			2	6	9
Total	31	29	1	49	116	327	553
				OV-1B, OV-1C, OV-1D (T53-L-7, -15, -701)			
1970	2			1	3	32	38
1971				4		70	74
1972	2			2		26	30
1973	2					17	19
1974*						6	6
Total	6			7	3	151	167

*1 Jan-31 Mar

hours should have been reported in 1,829 crash facts messages, but were reported in only 1,058 (57.8%). This situation alone makes it impossible to determine at what hour level an engine mishap is most likely to occur for a given type of engine. If local determination cannot be made as to why the engine failed, send it in for teardown analysis as stated in AR 95-5, change 3, paragraph 11-5.

The second problem is that units are not submitting Equipment Improvement Recommendations (EIR's). The EIR program is a key factor in the effort to improve systems reliability. The lack of participation in the EIR program serves to perpetuate needless accidents.

Mishap Classification and Location. Table 3 shows the total number of T53 engine-related mishaps by type classification and location from 1 January 1970 through 31 March 1974. This table is in three sections: (a) aircraft powered by the T53-L-13 series engine, (b) aircraft powered by the T53-L-11 series engine, and (c) aircraft powered by the T53-L-7, 15, and 701 turboprop series engines.

Mishap Frequency Rates. Yearly engine mishap frequency rates per 100,000 flying hours are shown in table 4. Table 4 is separated into three sections by T53 engine series.

Injuries. Injury classification by type aircraft is shown in table 5. This table also shows the number of people on board by aircraft type.

Engine Operating Hours. Table 6 shows operating hours (since new or overhaul) on the engine when the mishap occurred. As previously stated, the number of "unknowns" causes this table to be unreliable at best.

Accident/Incident Costs. Dollar costs of the mishaps covered in this report are reflected in table 7. The table is in three sections by engine model, year, and classification.

Phase of Operation. The phase of operation in which the mishap started is presented in table 8 in three sections—one for each model of engine concerned. Most of the in-flight mishaps occurred in cruise flight, with the next highest number occurring during the takeoff/climb phase.

Cause Factors. Engine-related mishap cause factors are listed in table 9. These cause fac-

tors are indicated as they were reported to USAAAVS in accident reports, crash facts messages, and teardown analysis reports. Of all engine failures or malfunctions listed, the major problems appear to have been divided between the fuel control/governor and lubrication system, with the exception of the OV-1 compressor. Failure of the T53-L-701 compressor is the major factor in the high mishap rate for the OV-1, as shown in table 4. ECP 176R1, improved compressor rotor assembly for the T53-L-13, was applied to -13 powered rotary wing aircraft in 1970 and held in abeyance for the T53-L-701 (same compressor as T53-L-13) until 1973, during which time the OV-1D had five known and three suspected compressor failures.

Fuel control/governor problems continue to be the major engine mishap cause factor with an average of 25.4 percent for all T53 engines. The lubrication system accounts for an average of 24.8 percent of the mishaps in rotary wing aircraft and only 11.11 percent in fixed wing aircraft. While 16.8 percent of rotary wing engine mishaps resulted in engine stops, only 11.1 percent of fixed wing mishaps resulted in engine stops.

SELECTED EIR's

Title: Fuel Control Assembly

Circumstances Prior to Difficulty: At 4987.6 aircraft hours, throttle friction was reported as being stiff and later as being stuck. Throttle grip was replaced.

Description of Difficulty: During training flight, pilot reported that throttle was stiff. Aircraft was test flown for this condition and throttle was

TABLE 3.–Mishap Location

Location	Total Loss	Major	Minor	Incident	Forced Landing	Precautionary Landing	Total
UH-1H, UH-1M, AH-1G, TH-1G (T53-L-13)							
Vietnam	95	134	7	156	297	560	1,249
CONUS	5	7		30	68	382	492
Other	2	1		1	14	34	52
Germany		2		2	7	44	55
Alaska					2	3	5
Korea					2	15	17
Canal Zone					2	2	4
Hawaii	1			2	5	12	20
Total	103	144	7	191	397	1,052	1,894
UH-1B, UH-1C, UH-1D (T53-L-11)							
Vietnam	19	16		10	33	28	106
CONUS	8	12		23	57	203	303
Other				3	11	26	40
Germany	3			4	6	27	40
Alaska				1			1
Korea	1	1	1	8	6	38	55
Canal Zone					2	4	6
Hawaii					1	1	2
Total	31	29	1	49	116	327	553
OV-1B, OV-1C, OV-1D (T53-L-7, -15, -701)							
Vietnam	3			4	2	66	75
CONUS				1	1	57	59
Other	1					5	6
Germany	2			1		16	19
Alaska						2	2
Korea				1		5	6
Total	6			7	3	151	167

TABLE 4.—Mishap Frequency Rate Per 100,000 Flying Hours

Year	No. Mishaps	Flying Hours	Rate
UH-1H, UH-1M, AH-1G, TH-1G (T53-L-13)			
1970	718	2,006,647	35.78
1971	551	1,509,667	36.50
1972	294	990,293	29.69
1973	261	799,451	32.65
1974*	70	143,256	48.86
Total	1,894	5,449,314	34.75
UH-1B, UH-1C, UH-1D (T53-L-11)			
1970	259	827,886	31.28
1971	195	496,915	39.24
1972	52	216,819	23.98
1973	38	176,642	21.51
1974*	9	24,699	36.44
Total	553	1,742,961	31.72
OV-1B, OV-1C, OV-1D (T53-L-7, -15, -701)			
1970	38	84,006	45.23
1971	74	68,335	108.29
1972	30	34,290	87.49
1973	19	22,409	84.79
1974*	6	3,765	159.36
Total	167	212,805	78.47

*1 Jan-31 Mar

found to be excessively stiff. Throttle friction did not appear to be properly adjusted to allow complete friction to be removed. Throttle friction blocks were cleaned, but this did not correct the discrepancy. Continued investigation to determine the cause of the stiff throttle disclosed that subject fuel control assembly was defective (power shaft excessively stiff).

Action Taken: Fuel control assembly was removed and replaced with a serviceable like item.

Title: Gas Turbine Engine

Circumstances Prior to Difficulty: Approximately 1 hour prior to this failure, pilots reported rapid popping from engine. Ground personnel told them that engine had spurted fireballs out of tail pipe during hover to takeoff area. There were no unusual instrument indications and aircraft continued to operate normally. This was the only reported incident in the aircraft history. During subsequent maintenance test flight by unit aircraft maintenance officer in attempt to assure airworthiness, engine experienced several rapid compressor stall-type surges in stable right turn of closed traffic pattern at 700 feet agl. Because of altitude and approaching aircraft, pilot did not observe instruments while making emergency landing. Observer also did not note instrument readings. Engine stabilized after landing was made and aircraft was hovered approximately 300 yards to maintenance area.

Description of Difficulty: During inspection of engine the following items were noted. All parts are from TM 55-2840-229-34P, dated 25 June 1973. Valve, air bleed, FSN 2915-647-1666, P/N 76285, fig. 72, ind. 25, was clogged with carbon. On tube assembly, feed back, FSN 2840-925-2973, P/N 1-180-160-01, fig. 68, ind. 23, rod end bearing, FSN 3120-904-9829, P/N 1-300-341, fig. 68, ind. 18, attached to fuel control actuating arm for the variable inlet guide vane was bent approximately 20 degrees. Housing assembly, impeller, FSN 2840-522-3799, P/N 1-100-090-13, fig. 49, ind. 1, upper half was cracked on left side approximately 4 inches in length running longitudinally in radius below mount pad for ignition excitor. Minor damage was noted on first, second, and third stage axial compressor blades. However, this damage was negligible and repaired in accordance with instructions in TM 55-2840-229-24.

Action Taken: Engine was removed and replaced with QCA engine on hand. Engine returned through supply channels marked as an EIR exhibit to ARADMAC for teardown analysis of possible compressor damage during stalls.

TABLE 5.—Injury Classification

Type Aircraft	Number Injuries	Minor	Major	Fatal	Total Aboard
UH-1H	3,115	149	83	143	3,490
AH-1G	569	35	20	4	628
UH-1D	823	23	7	4	857
OV-1	207		2	10	219
UH-1B	418	20	2	11	451
UH-1M	47	1			48
UH-1C	144	17	13	9	183
TH-1G	54				54
Total	5,377	245	127	181	5,930

TABLE 6.–Time When Failure/Malfunction Occurred (Hours Since New or Overhaul)

Operating Hours	1970	1971	1972	1973	1974*	Total
T53-L-13 Engine						
0-100	62	19	2	3	3	89
101-200	37	16	1	11	2	67
201-300	47	18	2	9	1	77
301-400	54	13	1	3	1	72
401-500	35	22		5	3	65
501-600	31	16		8	2	57
601-700	26	7	1	4	1	39
701-800	17	3		5	2	27
801-900	19	3	1	1		24
901-1000	17	2		3		22
1001 & over	13	3	2	5	2	25
Unknown	210	170	187	133	43	743
Total	568	292	197	190	60	1,307
T53-L-11 Engine						
0-100	12	7	1	1		21
101-200	11	4				15
201-300	9	6		1		16
301-400	11	10		2	3	26
401-500	11	4		1		16
501-600	5	1				6
601-700	2	3				5
701-800	10					10
801-900	3	4				7
901-1000	4	1				5
1001 & over	20	7	2	2		31
Unknown	114	72	33	24	3	246
Total	212	119	36	31	6	404
T53-L-7, -15, -701 Engine						
0-100	2	4		1		7
101-200	1	1		1	1	4
201-300	4	2		1		7
301-400	3	1	1	2		7
401-500	2			4		6
501-600		2		1		3
601-700	1					1
701-800		1		2		3
801-900						
901-1000	2	3				5
1001 & over	1	5				6
Unknown	14	22	25	5	3	69
Total	30	41	26	17	4	118

*1 Jan-31 Mar

Title: Turbine Engine

Circumstances Prior to Difficulty: Aircraft was used regularly for training flights without armament subsystems installed. Records showed no engine overspeeds or overtorque. Aircraft had similar problem 41 hours ago with same engine which was corrected by replacing fuel control assembly. At that time, bleed band assembly was popping open with power setting changes. Fuel control change corrected problem.

Description of Difficulty: Pilot reported what he thought to be an engine surge or compressor stall during flight. Aircraft was landed at home station without further incident. Pilot stated he heard one loud report from engine compartment area with a corresponding rise in egt and a yawing motion of the aircraft. Inspection of airframe and powertrain components was begun. Inspection revealed nothing to indicate a surge had occurred. Centrifugal and axial compressor halves were removed to inspect compressor for possible erosion and FOD. No FOD was found in axial compressor. However, 2-inch piece of blade material was missing from centrifugal impeller assembly. The single blade failure of the impeller, FSN 2840-176-3745, starts approximately 1½ inches behind the leading edge of the blade. There is no FOD to the leading edge of the failed blade, and it appears the blade material has been breaking away a little at a time from the dirt streaking marks at the blade root.

Action Taken: Engine assembly was removed from aircraft. Engine is available as exhibit, pending disposition instructions.

Title: Fuel Control

Circumstances Prior to Difficulty: Aircraft had been operating under normal conditions prior to detection of rpm fluctuation. Conditions were VFR with touch-and-go training in progress. On fifth landing, pilot noticed rpm fluctuation (100-500 rpm's) during power changes. Engine was installed by direct support maintenance 20 aircraft hours prior to difficulty, with zero hours since overhaul and 1,301 hours since new.

Description of Difficulty: During fifth landing of touch-and-go training, pilot noticed fluctuation of engine rpm when collective was lowered. When collective was raised prior to takeoff, engine rpm fluctuated again. Aircraft was flown back to hangar area.

TABLE 7.—Engine Failure Mishap Cost

Year	Total Loss	Major	Minor	Incident	Forced Landing
			T53-L-13		
1970	$12,256,875	$3,804,051	$104,484	$242,277	
1971	5,181,936	2,882,055	2,118	143,915	$100
1972	2,152,910	1,077,626	31,491	63,490	
1973	1,389,043	319,895		41,822	
1974*	293,070	64,000		13,306	
Total	$21,273,834	$8,147,627	$138,093	$504,810	$100
			T53-L-11		
1970	$ 971,369	$ 510,835		$ 86,560	
1971	2,045,913	630,056		35,426	
1972	244,760		$3,741	11,063	
1973	727,024	39,657		4,641	
1974*		64,000			
Total	$3,989,066	$1,244,548	$3,741	$137,690	
			T53-L-7, -15, -701		
1970	$1,058,540				
1971				$ 7,650	
1972	3,091,606			55,500	
1973	4,066,132				
1974*					
Total	$8,216,278			$63,150	

*1 Jan-31 Mar

Action Taken: Fuel control was replaced with a serviceable like item.

Title: Fuel Control Assembly
Circumstances Prior to Difficulty: At 2,674 aircraft hours, torque pressure gauge was fluctuating as much as 4 psi. Gauge was replaced. At 2,675 aircraft hours, rpm was noted to be fluctuating when power was changed. During test flight, overspeed governor was requested to be replaced due to slow rpm response and N1, N2, and torque fluctuation. Overspeed governor was replaced. However, engine still fluctuated 200 rpm when increased or decreased.
Description of Difficulty: During preflight operation, engine rpm was reported as surging at 6000 rpm for as much as 200 rpm. During maintenance operational check by test pilot, no fluctuation in emergency governor position was noted and overspeed governor was requested to be replaced. Governor was replaced and aircraft was test flown. However, rpm still fluctuated at 6000 rpm. Fuel control was then replaced and aircraft test flown and released.
Action Taken: Fuel control assembly was removed and replaced with a serviceable like item.

TABLE 8.—Phase of Operation When Engine Failure/Malfunction Occurred

Phase of Operation	T53-L-13	T53-L-11	T53-L-7, -15, -701
Stationary	19	7	
Takeoff/Climb	222	54	22
Hover	159	38	
Descent	19	8	7
Landing	176	48	18
Cruise	911	226	98

Title: Turbine Engine
Circumstances Prior to Difficulty: Approximately 15 hours after engine replacement, aircraft underwent 100-hour PMP inspection, including removal/inspection and reinstallation of engine chip detector. Chip detector at time of PMP inspection revealed no abnormal engine wear.
Description of Difficulty: During normal flight, engine oil chip detector light illuminated on master caution panel. Suspect removal and reinstallation of chip detector during 100-hour inspection caused metal chip to break off from thread surface, FSN 2840-857-3622.
Action Taken: Chip detector was removed for inspection, which revealed small metal chip completed circuit on plug. Chip of metal appeared to be of the same substance and radius as that of the thread face.

TABLE 9.– Cause Factors

Factors	T53-L-13	T53-L-11	T53-L-7, -15, -701
Compressor	1	12	13
Turbine Section	28	13	6
Exhaust Diffuser Section	7	5	1
Accessory Drive Section	41	20	3
Main Bearing	72	25	6
Lube System	212	61	6
Fuel Control/Governor	214	65	14
Anti-ice	6	1	
Inlet Section	13	3	
Fuel Section	51	33	5
Chip Detector	449	60	109
FOD	57	17	3
Engine Stopping	244	76	21
Maintenance	104	47	3

TABLE 10.–T53 Engine Growth History

	L-1	L-3, L-5	L-7, L-9, L-11	L-13, L-701
Shaft Horsepower	860	900	1,100	1,400
Gas Producer (Compressor) Speed	24,200	24,100	24,400	25,400
Pressure Ratio	6.0	6.0	6.2	7.6
Airflow	10.4	10.4	10.6	12.2

1. Reduction Gear Assembly
2. Propeller Reduction Sun Gear
3. Propeller Shaft Rear Bearing Support Assembly
4. Accessory Drive Carrier Assembly
5. Overspeed Governor and Tachometer Drive Assembly
6. Inlet Housing Assembly
7. Accessory Drive Gearbox Assembly
8. Compressor and Impeller Housing Assemblies Upper Half
9. Compressor Rotor Assembly
10. Compressor and Impeller Housing Assemblies Lower Half
11. Diffuser Housing
12. Rear Bearing Housing
13. Combustion Chamber Deflector
14. First Stage Turbine Nozzle and Flange Assembly
15. First Stage Turbine Rotor
16. Power Turbine Nozzle and Cylinder Assembly
17. Combustion Chamber Assembly
18. V-Band and Assembly
19. Second Stage Turbine Rotor Assembly
20. Exhaust Diffuser
21. Fire Shield Assembly
22. Support Cone Assembly
23. Combustor Turbine Assembly

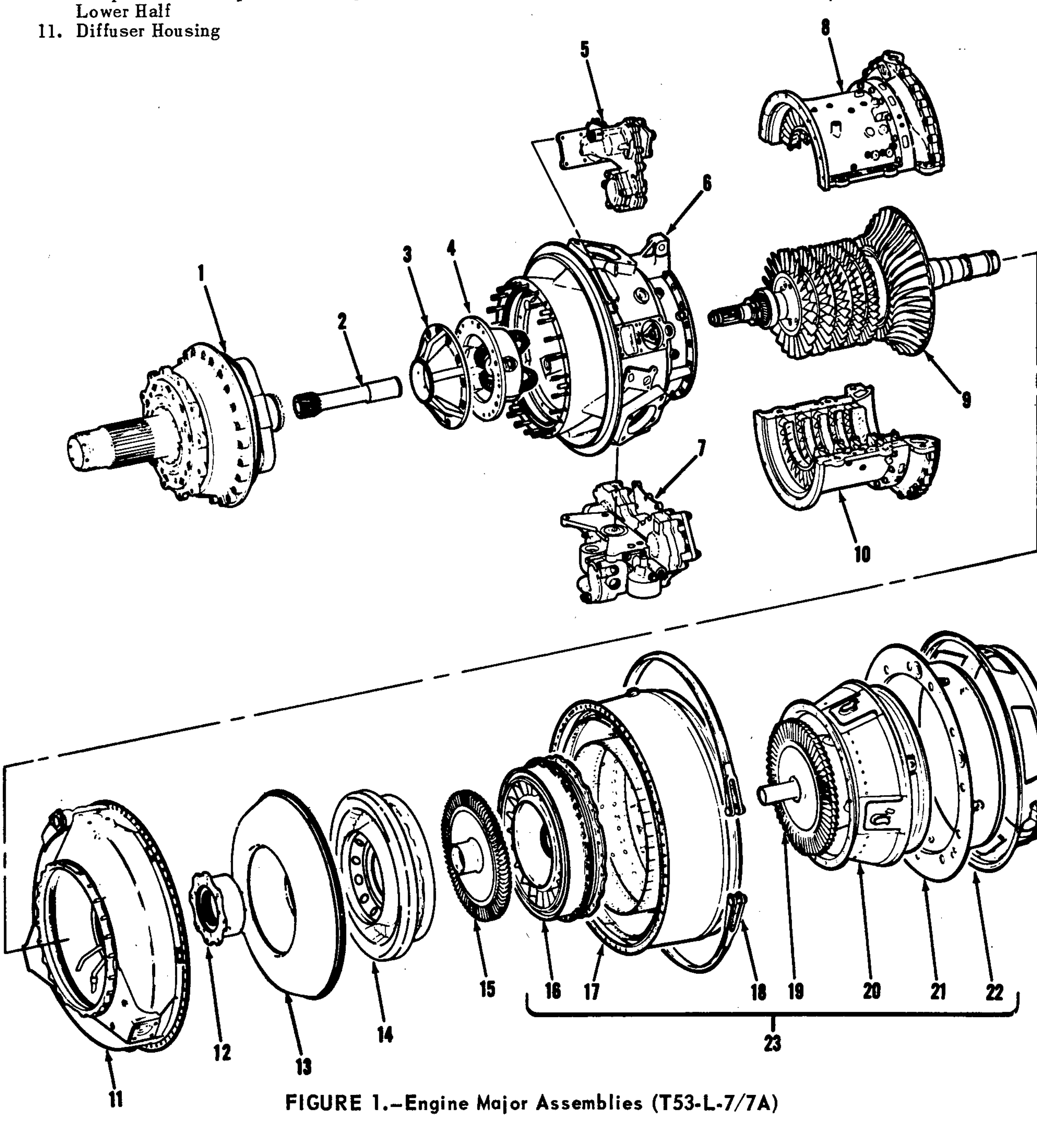


FIGURE 1.–Engine Major Assemblies (T53-L-7/7A)

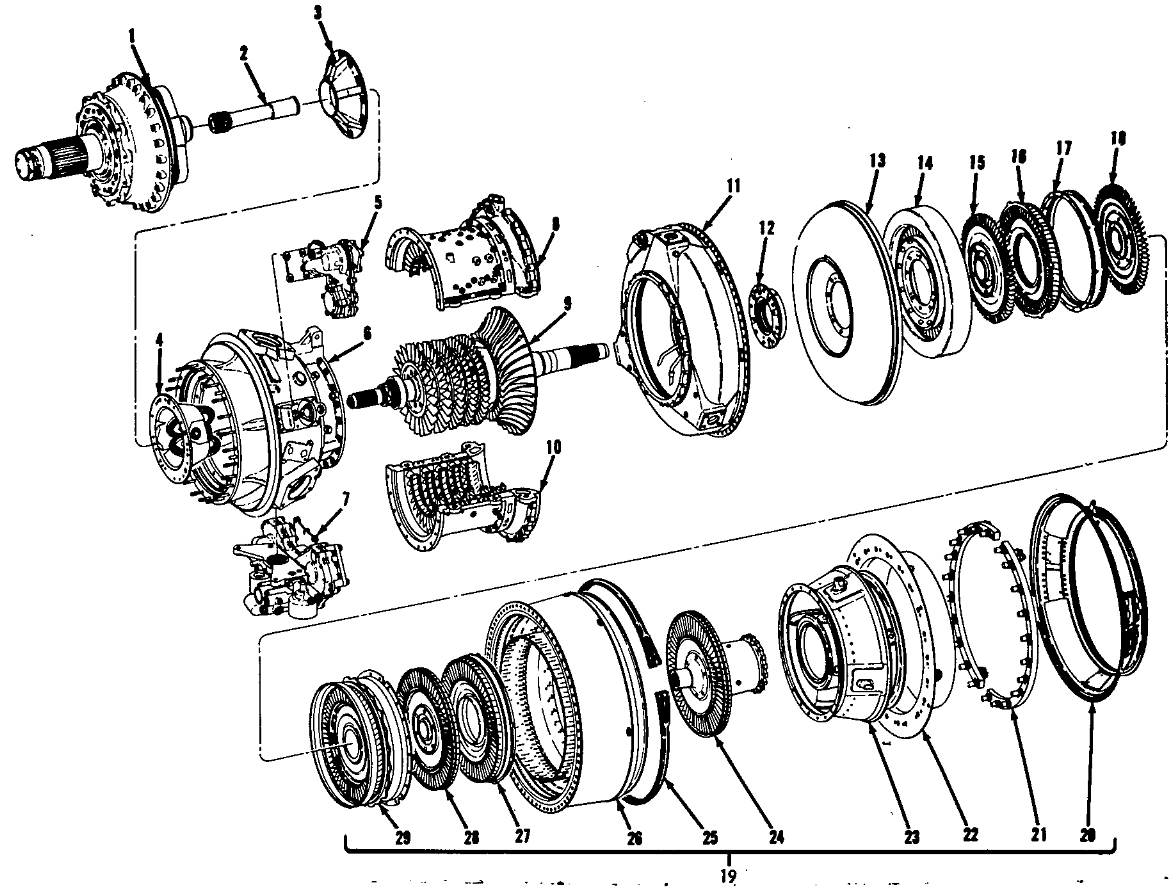


FIGURE 2.–Engine Major Assemblies (T53-L-15)

1. Reduction Gear Assembly
2. Propeller Reduction Sun Gear
3. Propeller Shaft Rear Bearing Support Assembly
4. Accessory Drive Carrier Assembly
5. Overspeed Governor and Tachometer Drive Assembly
6. Inlet Housing Assembly
7. Accessory Drive Gearbox Assembly
8. Compressor and Impeller Housing Assemblies Upper Half
9. Compressor Rotor Assembly
10. Compressor and Impeller Housing Assemblies Lower Half
11. Diffuser Housing
12. Rear Bearing Housing
13. Combustion Chamber Deflector
14. First Stage Gas Producer Nozzle
15. First Stage Gas Producer Turbine Rotor Assembly
16. Second Stage Gas Producer Nozzle
17. Second Stage Gas Producer Cylinder
18. Second Stage Gas Producer Turbine Rotor Assembly
19. Combustor Turbine Assembly
20. Exhaust Diffuser Support Cone Assembly
21. Main Fuel Manifold Assembly
22. Fire Shield Assembly
23. Exhaust Diffuser Assembly
24. Power Turbine Rotor and Bearing Housing Assembly
25. V-Band Coupling
26. Combustion Chamber Assembly
27. Second Stage Power Turbine Nozzle
28. First Stage Power Turbine Rotor
29. First Stage Power Turbine Assembly

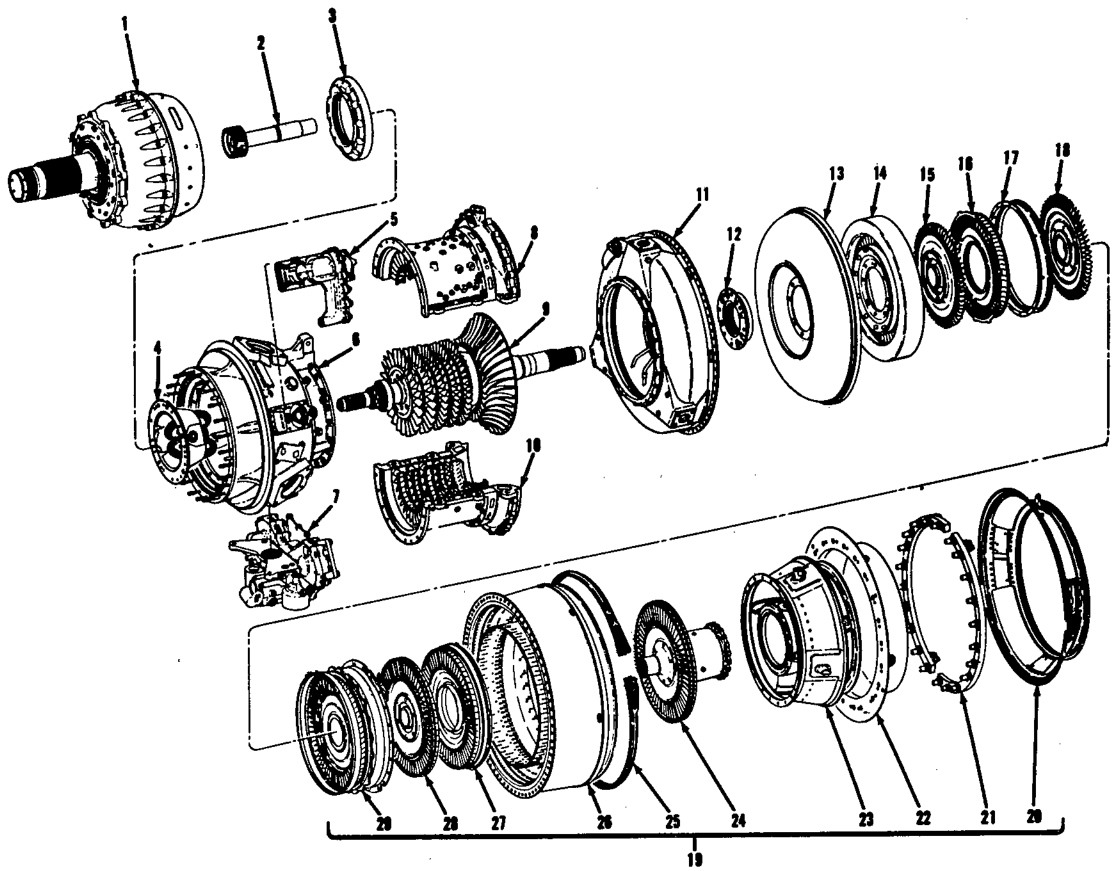


FIGURE 3.–Engine Major Assemblies (T53-L-701)

1. Reduction Gear Assembly
2. Propeller Reduction Sun Gear
3. Propeller Shaft Rear Bearing Support Assembly
4. Accessory Drive Carrier Assembly
5. Overspeed Governor & Tachometer Drive Assembly
6. Inlet Housing Assembly
7. Accessory Drive Gearbox Assembly
8. Compressor and Impeller Housing Assemblies Upper Half
9. Compressor Rotor Assembly
10. Compressor and Impeller Housing Assemblies Lower Half
11. Diffuser Housing
12. Rear Bearing Housing
13. Combustion Chamber Deflector
14. First Stage Gas Producer Nozzle
15. First Stage Gas Producer Turbine Rotor Assembly
16. Second Stage Gas Producer Nozzle
17. Second Stage Gas Producer Cylinder
18. Second Stage Gas Producer Turbine Rotor Assembly
19. Combustor Turbine Assembly
20. Exhaust Diffuser Support Cone Assembly
21. Main Fuel Manifold Assembly
22. Fire Shield Assembly
23. Exhaust Diffuser Assembly
24. Power Turbine Rotor and Bearing Housing Assembly
25. V-Band Coupling
26. Combustion Chamber Assembly
27. Second Stage Power Turbine Nozzle
28. First Stage Power Turbine Rotor
29. First Stage Power Turbine Assembly

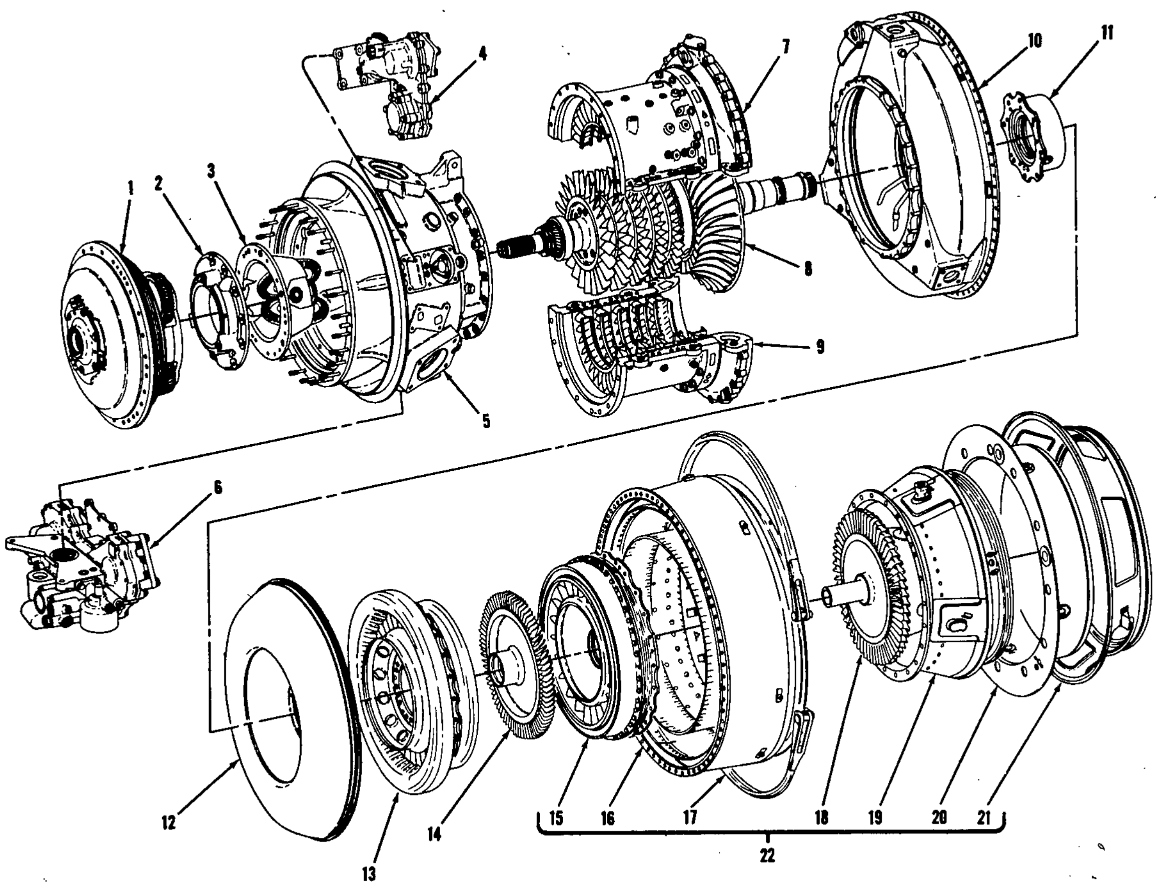


FIGURE 4.–Engine Major Assemblies (Typical) (T53-L-9A and L-11 Series)

1. Output Reduction Carrier and Gear Assembly
2. Oil Transfer Support Assembly (T53-L-11 S/N Suffix "A" and T53-L-11B) Overspeed Governor and Tachometer Drive Support Assembly (T53-L-9A, L-11, and L-11A)
3. Accessory Drive Carrier Assembly
4. Overspeed Governor and Tachometer Drive Assembly
5. Inlet Housing Assembly
6. Accessory Drive Gearbox Assembly
7. Compressor and Impeller Housing Assembly Upper Half
8. Compressor Rotor Assembly
9. Compressor and Impeller Housing Assembly Lower Half
10. Diffuser Housing
11. Rear Bearing Housing
12. Combustion Chamber Deflector
13. First Stage Turbine Nozzle and Flange Assembly
14. First Stage Turbine Rotor
15. Power Turbine Nozzle and Cylinder Assembly
16. Combustion Chamber Assembly
17. V-Band Assembly
18. Second Stage Turbine Rotor Assembly
19. Exhaust Diffuser
20. Fire Shield Assembly
21. Support Cone Assembly
22. Combustor Turbine Assembly

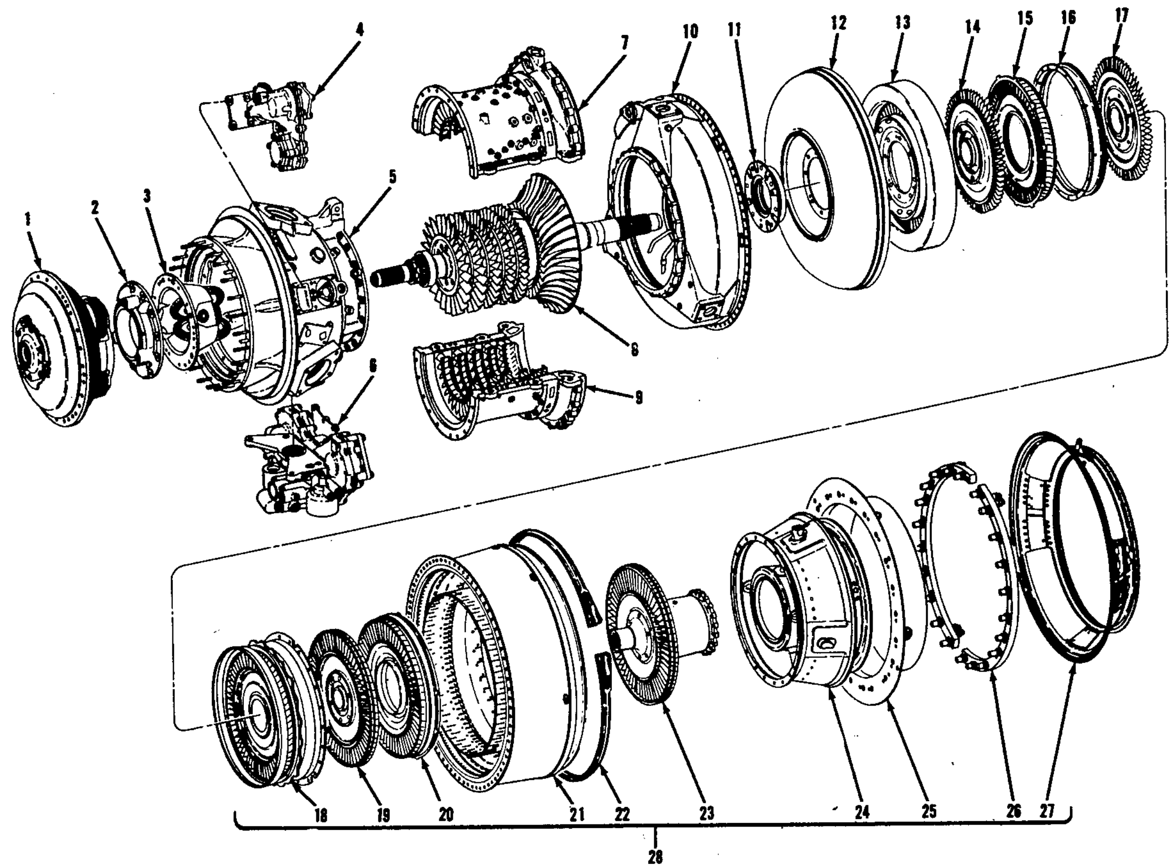


FIGURE 5.–Engine Major Assemblies (Typical) (T53-L-13 Series)

1. Output Reduction Carrier and Gear Assembly
2. Oil Transfer Support Assembly
3. Accessory Drive Carrier Assembly
4. Overspeed Governor and Tachometer Drive Assembly
5. Inlet Housing Assembly
6. Accessory Drive Gearbox Assembly
7. Compressor and Impeller Housing Assembly Upper Half
8. Compressor Rotor Assembly
9. Compressor and Impeller Housing Assembly Lower Half
10. Diffuser Housing
11. Rear Bearing Housing
12. Combustion Chamber Deflector
13. First Stage Turbine Nozzle Assembly
14. First Stage Gas Producer Turbine Rotor Assembly
15. Second Stage Turbine Nozzle Assembly
16. Second Stage Gas Producer Cylinder
17. Second Stage Gas Producer Turbine Rotor Assembly
18. First Stage Power Turbine Nozzle
19. First Stage Power Turbine Rotor
20. Second Stage Power Turbine Nozzle
21. Combustion Chamber Assembly
22. V-Band Assembly
23. Power Turbine Rotor and Bearing Housing Assembly
24. Exhaust Diffuser
25. Fire Shield Assembly
26. Fuel Manifold Assembly
27. Exhaust Diffuser Support Cone Assembly
28. Combustor Turbine Assembly

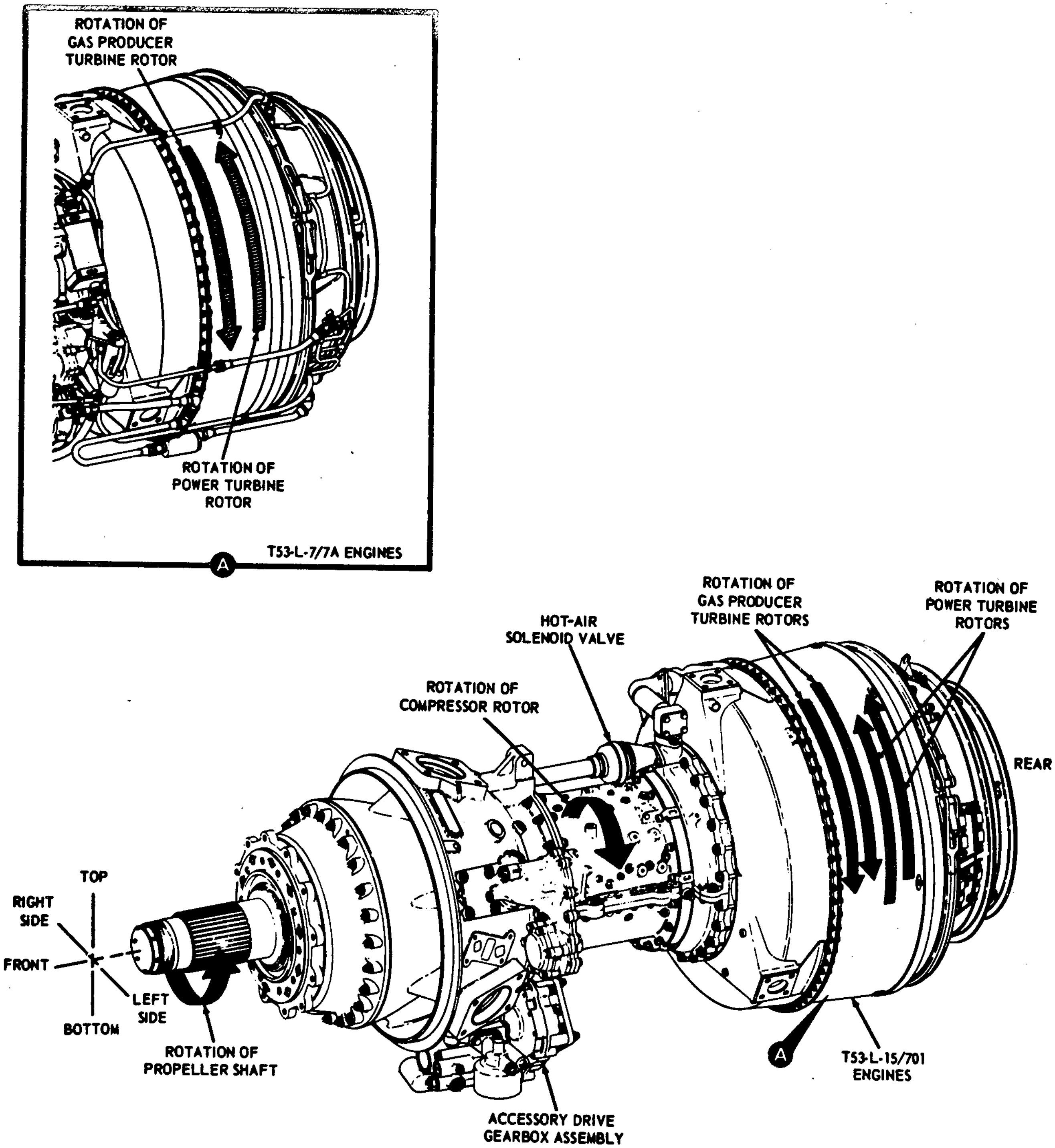
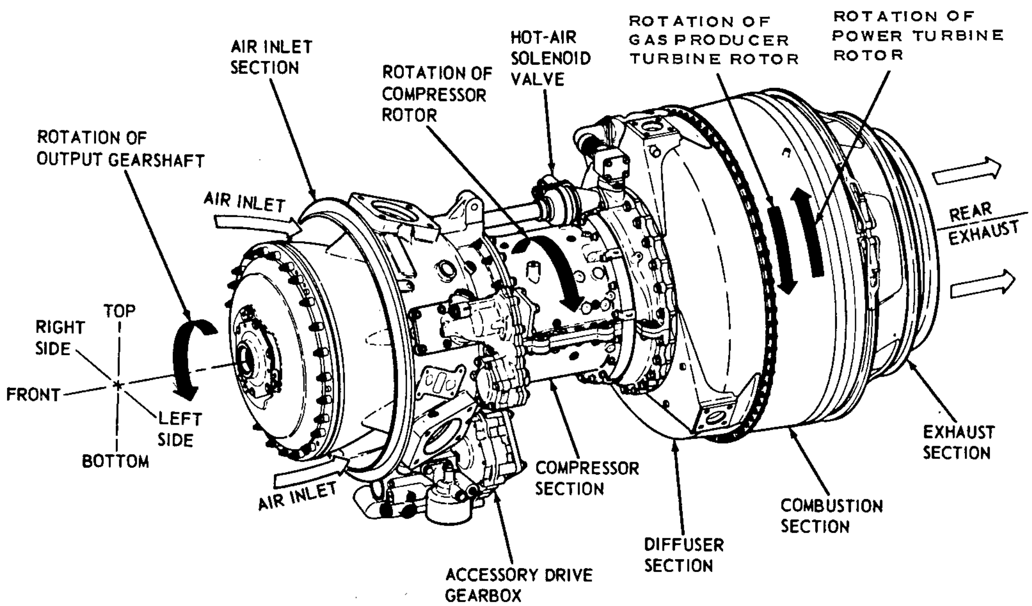
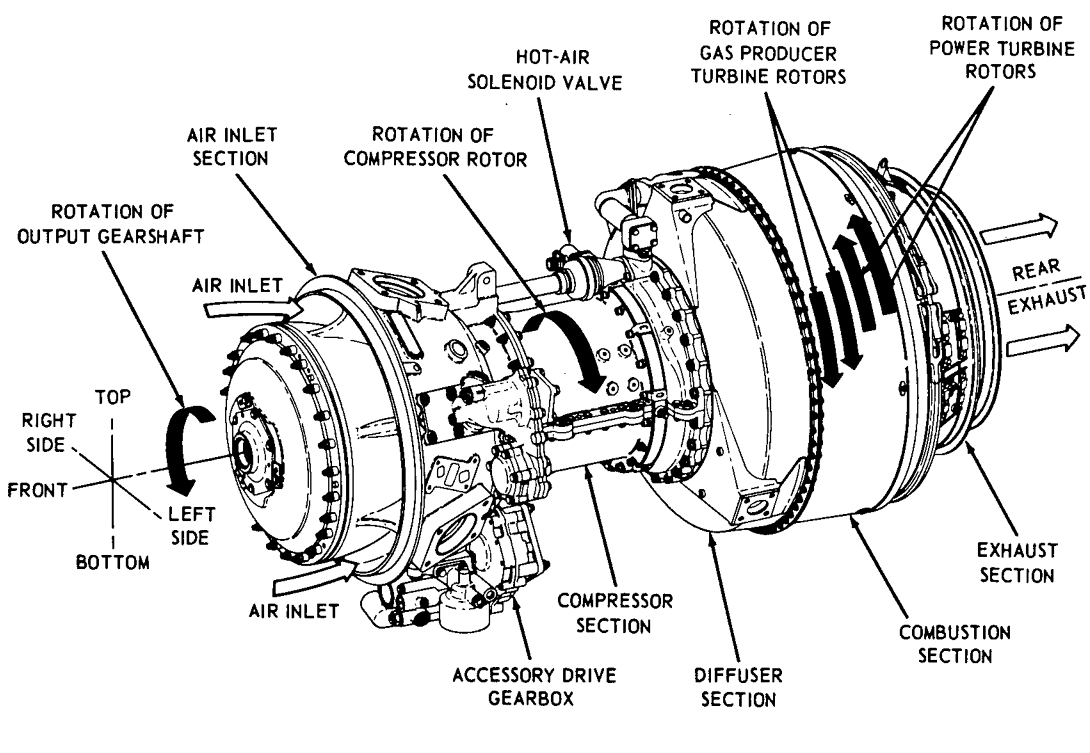


FIGURE 6.–Directional References (Typical)



T53-L-9A AND T53-L-11 SERIES ENGINES



T53-L-13 SERIES ENGINES

FIGURE 7.—Directional References

APPENDIX A

POWERPLANT DESCRIPTION

Lycoming Field Service Note No. 54 (Reissue)
Subject: T53 Series Engine Characteristics
Models Affected: All T53 Series Engines

NOTE

Field Service Note No. 54 (Reissue) supersedes Field Service Note No. 54, dated 22 December 1968.

1. PURPOSE

To provide Avco Lycoming Field Service Representatives with a description of each model within the T53 series, the following major characteristics are given.

NOTE

Time Between Overhaul (TBO) and Time Between Inspection (TBI) have purposely been omitted from this Field Service Note because they often change. If information of this nature is needed, refer to the appropriate Maintenance Manual.

2. INFORMATION

a. All T53 series engines to date have the following major configuration characteristics.

(1) Reduction gear.

(2) Five stage axial compressor.

(3) Centrifugal compressor.

(4) Reverse flow external annular combustion chamber.

(5) Free power turbine.

b. The T53 series engine can be used in a turboshaft or turboprop configuration; however, different reduction gears and fuel controls are required for each application.

c. Table 1 provides a brief synopsis of engine characteristics. All engine performance is Model Specification Data with no installation losses.

d. The following is a synopsis of specific engine characteristics.

(1) *T53-L-5 (Turboshaft)*—This engine is an improved version of the basic T53 turboshaft engine, incorporating an improved reduction gear.

(2) *T53-L-7 (Turboprop)*—This engine is an improved version of the basic T53 turboprop engine and has the following improvements. (Engine block numbers range from LE05001 to LE05444.)

(a) An improved helical reduction gear.

(b) A fuel heater for cold weather operations at altitude with JP-5.

(c) A refined combustor, a one-piece scoopless liner, and improved T-Canes, which enable it to operate on JP-4 and JP-5 fuel.

(d) Transient airbleed which allows faster engine accelerations.

(e) A spring-loaded, number one bearing.

(f) Improved air diffuser (piggy back).

(3) *T53-L-7A (Turboprop)*—This is the "Project Long Life" version of the T53-L-7 engine which contains extended life components. Performance is the same as the T53-L-7, but engine reliability and life have been improved. Refer to paragraph 3 for an explanation of "Project Long Life."

(4) *T53-L-9 (Turboshaft)*—This engine has increased power over the T53-L-5 series by virtue of increased fuel flow. To withstand the higher combustion temperatures generated by the increased fuel flow, the scoops and combustor liner were coated with a heat-resisting ceramic. In addition, the engine has a refined aerodynamic design of the air diffuser and an improved torquemeter system (cast piston rings).

NOTE

The T53-L-9 engine incorporates the same fuel regulator and overspeed gov-

TABLE 1.–Engine Characteristics

Engine Model	Shaft Horsepower (Standard Day*)	Type of Reduction Gear	CECO Fuel Regulator	Overspeed Governor	Applicable to Aircraft Model
T53-L-5	960	K-2	TA-2B	PTG-1	UH-1B
T53-L-7	1100	–	TA-2F	PTG-2	OV-1A/B/C
T53-L-7A	1100	–	TA-2F	PTG-2	OV-1A/B/C
T53-L-9	1100	K-2	TA-2B	PTG-1	UH-1B/D
T53-L-9A	1100	K-2	TA-2B	PTG-1	UH-1B/C/D
T53-L-9B	1100	K-2	TA-2B	PTG-1	UH-1B/C/D (Australian)
T53-L-11	1100	K-2	TA-2G	PTG-3	UH-1B/C/D/E
T53-L-11 S/N Suffix A	1100	K-4 (24 tooth)	TA-2G	PTG-3	UH-1B/C/D/E
T53-L-11A	1100	K-2	TA-2G	PTG-5	HH-43F
T53-L-11A S/N Suffix A	1100	K-4 (24 tooth)	TA-2G	PTG-5	HH-43F
T53-L-11B	1100	K-4 (26 tooth)	TA-2G	PTG-3	UH-1B/C/D/E
T53-L-11C	1100	K-4 (26 tooth)	TA-2G	PTG-3	UH-1B/C/D/E
T53-L-11D	1100	K-4 (26 tooth)	TA-2G	PTG-3	UH-1B/C/D/E
T53-L-13	1400	K-4 (26 tooth)	TA-2S	PTG-3	UH-1H/L/M, AH-1G, HH-1H/K, TH-1L
T53-L-13 "Δ"**	1400	K-4 (26 tooth)	TA-2S	PTG-3	UH-1H/L/M, AH-1G, HH-1H/K, TH-1L
T53-L-13 S/N Suffix A	1400	K-4 (26 tooth)	TA-2S	PTG-3	UH-1H/L/M, AH-1G, HH-1H/K, TH-1L
T53-L-13A	1400	K-4 (26 tooth)	TA-2S	PTG-3	UH-1H/L/M, AH-1G, HH-1H/K, TH-1L
T53-L-13A S/N Suffix B	1400	K-4 (26 tooth)	TA-2S	PTG-3	UH-1H/L/M, AH-1G, HH-1H/K, TH-1L
T53-L-13B	1400	K-4 (26 tooth)	TA-2S	PTG-3	UH-1H/L/M, AH-1G, HH-1H/K, TH-1L
T53-L-15	1160	–	TA-2V-1, TA-2W	PTG-2	OV-1C
T53-L-15 "Δ"**	1160	–	TA-2V-1, TA-2W	PTG-2	OV-1C
T53-L-15 S/N Suffix A	1160	–	TA-2V-1, TA-2W	PTG-2	OV-1C
T53-L-701	1400	–	TA-2V-2	PTG-2	OV-1D
T53-L-701 S/N Suffix A	1400	–	TA-2V-2	PTG-2	OV-1D

*Temperature = 59° F., Pressure = 29.92 In. Hg.
**"Δ" = Delta stamped in the upper right hand corner of the data plate.

NOTE: All engine performance is Model Specification Data with no installation losses.

ernor as the T53-L-5. However, because of the different fuel requirements of both engines, external adjustments are necessary when interchanging the fuel regulators between T53-L-5 and T53-L-9 engines. Refer to UH-1B Organizational Maintenance Manual TM 55-1520-219-20 for a complete description of the necessary adjustments.

(5) *T53-L-9A (Turboshaft)*–This engine is the same as the T53-L-9 engine with one significant configuration improvement, the so-called "piggy-back" air diffuser. This design changed the point of customer bleed air extraction from the exit of the centrifugal compressor to the exit of the air diffuser. This improvement increased the surge margin of the engine.

(6) *T53-L-9B (Turboshaft)*–This engine is the same configuration as the T53-L-9 except that it incorporates a scoopless combustor which enables operation on both JP-4 and JP-5 fuel.

(7) *T53-L-11 (Turboshaft)*–This engine has the following improvements.

(a) A scoopless combustor and refined T-Canes which enable it to operate on JP-4 and JP-5 fuel.

(b) Transient airbleed which allows faster engine accelerations.

(c) A spring-loaded, number one bearing.

(d) Improved air diffuser (piggy back).

(8) *T53-L-11 Serial Number Suffix "A" (Turboshaft)*–This engine is the same as the T53-L-11 engine except that it incorporates an improved K-4 reduction gear that has the same output shaft spline (24 teeth) as the older K-2 type. The K-4 reduction gear is an improvement over the K-2 type in its horsepower capability and service life.

(9) *T53-L-11A (Turboshaft)*–This engine is the same as the T53-L-11 except that it incorporates an overspeed governor (PTG-5) with slightly different droop characteristics and a bleed band with a slower closing rate. This is necessary because the engine is used on the Air Force HH-43F helicopter which has special main rotor system dynamic characteristics.

(10) *T53-L-11A Serial Number Suffix "A"* *(Turboshaft)*—This engine is the same as the T53-L-11A except that it incorporates the improved K-4 reduction gear with the 24-tooth output shaft spline.

(11) *T53-L-11B (Turboshaft)*—This engine is the same as the T53-L-11 except that it incorporates a K-4 reduction gear that has a 26-tooth output shaft spline.

(12) *T53-L-11C (Turboshaft)*—This is the "Project Long Life" version of the T53-L-11 Serial Number Suffix "A" engine. Performance is the same as the T53-L-11 Serial Number Suffix "A," but engine reliability and life have been improved. Refer to paragraph 3 for an explanation of "Project Long Life."

(13) *T53-L-11D (Turboshaft)*—This is the "Project Long Life" version of the T53-L-11B engine. Performance is the same as the T53-L-11B, but engine reliability and life have been improved. Refer to paragraph 3 for an explanation of "Project Long Life."

(14) *T53-L-13 (Turboshaft)*—This engine is such a significant improvement over its predecessors that it is considered the beginning of a second generation of T53 engines. This generation is characterized by increased horsepower, improved engine efficiency, and greater growth potential. The T53-L-13 engine has the same frontal and envelope dimensions as the T53-L-11. Following are some of the significant improvements and configuration changes that are present on the T53-L-13.

(a) *Variable Inlet Guide Vanes (VIGV)*—The VIGV vary the angle of attack of the incoming air to the first stage compressor to provide sufficient surge margin throughout the engine operating range.

(b) *Transonic Compressor Blades*—The T53-L-13 engine requires about 20 percent greater airflow than T53-L-11 engines. To obtain this greater airflow while maintaining the same inlet area, a redesign of the first and second axial compressor stages was necessary. This redesign resulted in the transonic first and second axial compressor stages, i.e., airflow at the blade root is subsonic and airflow at the blade tip is supersonic. The remaining axial stages and centrifugal compressor are the same as the T53-L-11.

(c) *Atomizing Combustor*—The T53-L-13 engine incorporates an atomizing combustor as opposed to a vaporizing combustor on earlier T53 engines. Twenty-two atomizing fuel nozzles replace the familiar fuel vaporizers (T-Canes) found in earlier T53 engines.

(d) *Two Stage Gas Producer Turbine and Two Stage Power Turbine*—The increased power requirement of the compressor necessitated the incorporation of the two stage gas producer turbine and the increased power output of the engine necessitated the incorporation of the two stage power turbine. This accomplished the following.

1 Reduced the load on each turbine.

2 Increased thermodynamic efficiency because power is extracted in two steps rather than one.

3 Allows for growth of engine.

(e) *Performance*—T53-L-13 engines produce 1400 shaft horsepower on a standard day.

(15) *T53-L-13 With a "Δ" (Delta stamped in the upper right hand corner of the data plate) (Turboshaft)*—The "Δ" on the data plate signifies that this engine has a glass shot-peened, epoxy painted, second stage compressor disc (1-100-710-08).

(16) *T53-L-13 Serial Number Suffix "A" (Turboshaft)*—This engine is the same as the T53-L-13 except that it has a 34-blade second stage compressor disc (1-100-710-05) instead of the 36-blade disc. In addition, depending on availability of parts, engines with the -13 Serial Number Suffix "A" may incorporate the following:

(a) Improved No. 2 bearing seals. (ECP 139)

(b) Six-probe exhaust thermocouple harness which measures exhaust gas temperature at 12 locations, two on each probe. It provides a more accurate measurement of exhaust gas temperature than the older three-probe harness. (ECP 146)

(c) Improved No. 2 bearing scavenging system which is readily noticed because of the enlarged No. 2 bearing scavenge line. (ECP 148)

NOTE

This change necessitated an enlargement of the accessory drive gearbox scavenge port to accept the enlarged scavenge line.

(17) *T53-L-13A (Turboshaft)*—This engine is the same as the T53-L-13 except that the following improvements *have been* incorporated

at production.

(a) Improved No. 2 bearing seals. (ECP 139)

(b) Six-probe exhaust thermocouple harness. (ECP 146)

(c) Improved No. 2 bearing scavenging system. (ECP 148)

(d) Thirty-four-blade second stage compressor disc. (ECP 161)

(18) *T53-L-13A Serial Number Suffix "B" (Turboshaft)*—This engine is the same as the T53-L-13A except that it has a new fourth stage compressor rotor disc (1-100-244-08) which was machined from forgings with controlled flow and grain size. (ECP 196R1)

(19) *T53-L-13B (Turboshaft)*—This engine is the same as the T53-L-13 except that the following changes have been incorporated which significantly improve the engine reliability and extended component life.

(a) Six-probe exhaust thermocouple harness which measures exhaust gas temperature at 12 locations, two on each probe.

(b) Improved titanium compressor rotor assembly with bolted components eliminating the requirement for complex compression assembly and improved blade retention design for ease of maintenance in the field. (ECP 176)

(c) The incorporation of an integrally cast second stage gas producer nozzle made from Inco material which decreases the vulnerability to thermal damage allowing an increased interval between inspections. (ECP 177)

(d) The mandatory installation of the cast first stage gas producer nozzle. (ECP 155R)

(e) The mandatory installation of improved saw cut No. 2 bearing seals. (EO 69278)

(f) Vespel sun gear thrust washer. (EO 69458)

(20) *T53-L-15 (Turboprop)*—This engine is the turboprop counterpart of the T53-L-13 engine and is flat rated at 1160 shaft horsepower. A torque limiter reduces fuel flow so that 1160 shaft horsepower is not exceeded during MILITARY operation, thus protecting the reduction gearing from a possible overtorque condition. Engine numbers are LE01226 and subsequent.

NOTE

The T53-L-15 engine produces 1160 shaft horsepower up to a 95° F. day at sea level and/or 1160 shaft horsepower at 9000 feet under standard day conditions.

(21) *T53-L-15 With a "Δ" (Delta stamped in the upper right hand comer of the data plate) (Turboprop)*—T53-L-15 engines with serial numbers from LE01226 through LE01248 contain 36-blade second stage compressor discs. Of these engines, LE01242 through LE01248 have second stage compressor discs that are glass shot-peened and epoxy painted to help withstand tensile stresses. These engines are identified by a "Δ" (delta) stamped in the upper right hand corner of the engine data plate. Engine serial number LE01249 and subsequent incorporate the improved 34-blade disc.

(22) *T53-L-15 Serial Number Suffix "A" (Turboprop)*—This engine is the same as the T53-L-15 except that it has an improved fourth stage compressor rotor disc (1-100-244-08) which was machined from forgings with controlled flow and grain size. (ECP 196R1)

(23) *T53-L-701 (Turboprop)*—This engine is an improved version of the second generation T53 turboprop engines and incorporates the following:

(a) "Split power" reduction gear assembly which permits the full mechanical and thermodynamic capabilities of the compressor, gas producer, and power turbine assemblies.

NOTE

The engine will provide 1,400 shaft horsepower minimum on a 59° F. day at sea level. However, the engine will deliver 1,525 shaft horsepower at 43° F. and below at sea level for 30 minutes continuous maximum.

(b) Electric torquemeter system which provides torque measurements.

(c) New sun gear convex washer, fuel control, inlet housing, accessory drive gear carrier housing, and an overspeed governor and tachometer drive assembly.

(d) Impending oil bypass button and a start fuel purge system.

(e) Improved main carbon saw-cut bearing seals at the No. 2 bearing fore and aft positions, and a cast first stage gas producer nozzle.

(24) *T53-L-701 Serial Number Suffix "A" (Turboprop)*—This engine is the same as the T53-L-701 except that, starting with engine serial number LE30082A, it has an improved fourth stage compressor rotor disc (1-100-244-08)

which was machined from forgings with controlled flow and grain size. (ECP 196R1)

3. PROJECT LONG LIFE

a. Operational experience has shown that an increase in inspection interval (TBI) and Overhaul life (TBO) is feasible with the incorporation of improved components in the following engine models.

(1) T53-L-7 (Turboprop)

(2) T53-L-11 Serial Number Suffix "A" (Turboshaft)

(3) T53-L-11B (Turboshaft)

b. The selection of these engine models as long life candidates was based on the fact that they already contain substantial improvements which have been incorporated through modernization as a result of a product improvement program. The prior improvements are as follows.

(1) *K-4 reduction gear*—These improved gears offer a considerable increase in service life.

(2) *Position No. 1 bearing spring support*—This modification was incorporated to improve overall engine compressor vibration characteristics.

(3) *Improved main shaft seals*—A decrease in oil consumption and oil leakage was obtained by incorporating pressurized/radial labyrinth positive contact seals.

(4) *Scoopless combustor*—This improved combustor enables the engine to operate with a multi-fuel capability (JP-4 and JP-5).

(5) *Transient airbleed*—This features improved acceleration time.

(6) *Relocation of customer air supply (piggy back diffuser)*—This modification improves the engine altitude surge margin.

(7) *Dual oil capability*—The engines are qualified to operate on MIL-L-23699 or MIL-L-7808 lubricating oil.

c. The six improved components necessary to convert these engines to "long life" status are as follows.

(1) *Improved gas producer nozzle*—A cast nozzle (1-110-030-34) or brazed nozzle (1-110-030-36) composed of Inco 713 with a heat resistant coating (606B).

(2) *Improved gas producer turbine blades with improved blade retention*—The blade material was changed to Inco 713 and coated with 606B. The blade part number is changed to 1-100-428-18. The assembly (blades and disc) is part number 1-100-490-08. In addition, the retaining pin (1-140-023-01) has been shortened to ensure better staking of the blades to the disc.

NOTE

A new staking tool is required with these pins.

(3) *Improved No. 2 bearing lubrication system*—An additional oil jet has been drilled in the housing (1-110-310-07) and the orifice size of the existing two jets in the retainer (1-110-314-08) has been decreased.

(4) *Improved flexible combustor curl (1-110-440-02)*—Mechanical fabrication of the combustor curl has been refined.

(5) *Improved cast vaporizer tube seals*—The combustor liner has been changed to introduce a new vaporizer seal, featuring an improved method of retention, using a spring washer and retaining ring.

(6) *Improved fifth stage titanium compressor disc (1-100-417-05)*—The superior strength of titanium greatly increases the life of this component. The original disc was aluminum.

d. When all of the six improved components have been incorporated, the engines are considered "long life" engines and are assigned a new designation as follows.

(1) T53-L-7 becomes T53-L-7A.

(2) T53-L-11 Serial Number Suffix "A" becomes T53-L-11C.

(3) T53-L-11B becomes T53-L-11D.

APPENDIX B

TBO AND INSPECTION REQUIREMENTS FOR LYCOMING AVIATION GAS TURBINE ENGINES

U. S. Military Models

Engine Model	TBO Hours	Internal Inspection Front End Hours	Internal Inspection Rear End Hours
T53-L-1A/1B	1200	1.	400
T53-L-7/9/9A/11/11 S/N Suffix A/11A/11A S/N Suffix A/11B	1200 2.	None	400 3.
T53-L-7A Project Long Life 4.	1800	None	600
T53-L-11C/11D Project Long Life 4.	1800	None	900
T53-L-13A/13A S/N Suffix B 5.	600	None	300
T53-L-13B 6.	1800 7.	None	900 8.
T53-L-15/15 S/N Suffix A 9.	1200	None	300 10. 600
T53-L-701/701 S/N Suffix A 11.	1200	None	600

NOTES:

1. A T53-L-1A engine front end inspection (reduction gearing) is required every 400 hours.
2. Engines operated at USAAVNC, Fort Rucker, AL and in the European theatre, have a TBO of 1600 hours.
3. Navy engines, hot-end inspection will be performed each odd calendar month or 440 hours.
4. Project "Long Life" engines have incorporated the following ECPs:
   a. Coated cast or fabricated gas producer nozzle (ECPs 109 and 124).
   b. Improved gas producer turbine blades (ECP 118).
   c. Improved No. 2 bearing lubrication (ECP 166).
   d. Flexible combustor deflector (E.O. T5296).
   e. Cast vaporizer tube seals (ECP 111).
   f. Titanium fifth stage compressor disc (ECP 131R).
5. T53-L-13A S/N Suffix B engines have incorporated an improved fourth stage disc (ECP 196R1).
6. T53-L-13B engines have incorporated:
   a. Cast first stage gas producer nozzle (ECP 155).
   b. Titanium compressor rotor (ECP 176R1).
   c. Cast second stage gas producer nozzle (ECP 177).
   d. "Saw cut" seals in No. 2 bearing position (E.O. 69279).
7. Engines operated at USAAVNC, Fort Rucker, AL, are operating in excess of 2400 hours.

8. Engines operated at USAAVNC, Fort Rucker, AL, have a TBI of 1200 hours.

9. T53-L-15 S/N Suffix A engines have incorporated an improved fourth stage disc (ECP 196R1).

10. a. Engine LE-01376 and subsequent, have a cast first stage gas producer nozzle incorporated and have a TBI of 600 hours.

b. Engine LE-01226 through 1375 have a TBI of 300 hours unless field retrofitted with a cast first stage gas producer nozzle (P/N 1-110-520-19), FSN 2840-570-9803, then a TBI of 600 hours is applicable. Check engine records prior to hot end inspection for determination of field retrofit. If questionable, a 300-hour hot end inspection is mandatory.

11. T53-L-701 S/N Suffix A engines have incorporated an improved fourth stage disc (ECP 196R1).